

SECU

AD-A240 468



ENTATION PAGE

Form Approved
OMB No 0704-0188

1a R		1b RESTRICTIVE MARKINGS	
2a SECURITY CLASSIFICATION AUTHORITY		3 DISTRIBUTION/AVAILABILITY OF REPORT	
2b DECLASSIFICATION/DOWNGRADING SCHEDULE			
4 PERFORMING ORGANIZATION REPORT NUMBER(S)		5 MONITORING ORGANIZATION REPORT NUMBER(S)	
6a NAME OF PERFORMING ORGANIZATION Dept. of Chemistry Cornell University	6b OFFICE SYMBOL (if applicable)	7a NAME OF MONITORING ORGANIZATION Office of Naval Research	
6c ADDRESS (City, State, and ZIP Code) Dept. of Chemistry Cornell University Ithaca, NY 14853		7b ADDRESS (City, State, and ZIP Code) Chemistry Program 800 N. Quincy Street Alexandria, VA 22217	
8a NAME OF FUNDING/SPONSORING ORGANIZATION Office of Naval Research	8b OFFICE SYMBOL (if applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER N00014-88-K-0139	
8c ADDRESS (City, State, and ZIP Code) Chemistry Program 800 N. Quincy St. Alexandria, VA 22217		10 SOURCE OF FUNDING NUMBERS	
		PROGRAM ELEMENT NO	PROJECT NO
		TASK NO	WORK UNIT ACCESSION NO
11 TITLE (Include Security Classification) Novel Conducting Solids - Final Report			
12 PERSONAL AUTHOR(S) Francis J. DiSalvo			
13a TYPE OF REPORT Final Technical Rpt	13b TIME COVERED FROM 11/87 TO 11/90	14 DATE OF REPORT (Year, Month, Day) 1991, Sept. 12	15 PAGE COUNT
16 SUPPLEMENTARY NOTATION			
17 COSATI CODES		18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB GROUP	
		Solid State Compounds	
		Nitrides	
		Electrical Properties	
19 ABSTRACT (Continue on reverse if necessary and identify by block number) A large family of novel nitride materials has been discovered and examined. Unusual structural, electrical and magnetic properties were found. Work continues in this field to better understand the scope of nitride chemistry in solids and the chemical and physical properties of these unique materials.			
20 DISTRIBUTION/AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS		21 ABSTRACT SECURITY CLASSIFICATION Unclassified	
22a NAME OF RESPONSIBLE INDIVIDUAL Dr. Mark Ross		22b TELEPHONE (Include Area Code) 202-696-4409	22c OFFICE SYMBOL

91-10780



[illegible]

OFFICE OF NAVAL RESEARCH
FINAL TECHNICAL REPORT

for

Contract # N00014-91-J-1269

R&T Code 4134037

Contract dates: Dec. 1, 1987 to Nov. 30, 1990

Synthesis of Novel Conducting Solids

Professor Francis J. DiSalvo

Department of Chemistry
Cornell University
Ithaca, NY 14853

May 30, 1991

Reproduction in whole, or in part, is permitted for any purpose of the United States Government.

* This document has been approved for public release and sale: its distribution is unlimited.

FINAL REPORT

Objectives of the Research

The synthesis of new oxides, sulfides and nitrides was undertaken with the objective of discovering novel conducting properties. One goal is to discover new classes of compounds that could be high temperature superconductors. Such discovery is hoped to lead to materials with better mechanical and electrical properties than the copper oxides and possibly to provide new perspectives on the mechanism of high temperature superconductivity. A second goal is to investigate little studied classes of materials for new chemical or physical behavior. While oxides as a class have been extensively studied, compounds such as ternary nitrides are almost completely unexplored. Since there are technologically important binary nitrides, such as AlN , Si_3N_4 and NbN , it is likely that studies of ternary nitrides will produce exciting advances. A final objective is to train undergraduate and graduate students to be creative in the production and characterization of both known and novel solid state materials. Such solid state chemistry has been a neglected area of science in the US, but an area critical to many technologies.

Research Findings to Date

We have discovered a large new family of compounds: the ternary nitrides. These compounds contain an electropositive metal, such as an alkali, alkaline earth or rare earth metal, and a transition metal or post-transition metal as well as nitrogen. These include: CaNiN (Technical Reports listed below, #5), Ca_2ZnN_2 (#6), Ca_3CrN_3 (#7), Ca_3MN with $\text{M} = \text{P}, \text{As}, \text{Sb}, \text{Bi}, \text{Ge}, \text{Sn}, \text{and Pb}$ (#8,9), Ta_3N_5 (#10). The synthesis, structure and chemical and physical properties of these materials reveal significant differences in behavior from other solid state compounds. There are about a hundred new nitrides that we have prepared and observed by powder x-ray diffraction. Unravelling the structure and properties of these materials will be the subject of future research.

As part of our studies we have also investigated a few unusual oxide materials that were made first by us. These include NdNiO_2 (#1), $\text{Ba}_2\text{Nb}_2\text{O}_7$, and $\text{Sr}_2\text{Nb}_2\text{O}_7$ (#12), and studies of strong oxidants for deintercalation of oxides and other solids (#2). At the same time we developed some instrumentation necessary to measure the density of small quantities of powdered solids to help in the structure determination of our new materials (#3). Finally, a review of the status of solid state chemistry and of our research was written by the invitation of Science (#4).

ONR Technical Reports

(Note: publication citation in journals is also given)

1. "Synthesis and Properties of NdNiO₃ Prepared by Low Temperature Methods", J. K. Vassiliou, M. Hornbostel, R. P. Ziebarth and F. J. DiSalvo, J. Solid State Chemistry **81**, 208 (1989)
2. "Powerful Oxidation Agents for the Oxidative Deintercalation of Lithium from Transition Metal Oxides", A. R. Wizansky, P. E. Rauch and F. J. DiSalvo, J. Solid State Chemistry **81**, 203 (1989)
3. "A Small, Inexpensive Apparatus for the Determination of the Density of Powdered Materials" M. Y. Chern, R. D. Mariani, D. A. Vennos and F. J. DiSalvo, Rev. of Scientific Instruments, **61**, 1733 (1990)
4. "Solid State Chemistry: A Rediscovered Chemical Frontier" F. J. DiSalvo, Science **247**, 649 (1990)
5. "Synthesis, Structure, Electrical and Magnetic Properties of CaNiN" M. Y. Chern and F. J. DiSalvo, J. Solid State Chemistry **88**, 459 (1990)
6. "Ca₂ZnN₂: A New Ternary Nitride" M. Y. Chern and F. J. DiSalvo, J. Solid State Chemistry, **88**, 528 (1990)
7. "Synthesis, Structure and Magnetic Properties of a Novel Nitride: Ca₃CrN₃" D. A. Vennos, M. E. Badding and F. J. DiSalvo Inorganic Chemistry, **29**, 4059 (1990)
8. "Synthesis, Structure and Properties of Anti-Perovskite Nitrides Ca₃MN, M = P, As, Sb, Bi, Ge, Sn, and Pb" M. Y. Chern, D. A. Vennos and F. J. DiSalvo. J. Solid State Chemistry (1991)
9. "The Structural Distortion of the Anti-Perovskite Nitride AsNCa₃" M. Y. Chern, F. J. DiSalvo, J. B. Parise and J. A. Goldstone, J. Solid State Chemistry (1991)
10. "The Structure of Ta₃N₅ at 16K by Time-of-Flight Neutron Diffraction" N. Brese, M. O'Keefe, P. E. Rauch and F. J. DiSalvo, Acta Cryst. **C47**, (1991)
11. "Synthesis Structure and Properties of a New Intermetallic Compound, Ca₇Ni₄Sn₁₃" D. A. Vennos, M. E. Badding and F. J. DiSalvo, J. less Common Metals **171**, (1991)
12. "Synthesis and Properties of Some New Reduced Niobate Compounds" C. E. Michelson, P. E. Rauch and F. J. DiSalvo, Materials Research Bulletin, **25**, 971 (1990)

Grad students and Post Docs that worked on the project:
(25% or greater support)

Grad Students: Ming Yau Chern
Jeff B. Davis
Scott H. Elder
Paul E. Rauch
Deborah A. Vennos
Abbigail R. Wizansky

Post Doctoral: Yannis K. Vassiliou
Carol Michelson